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(54) **METHOD AND APPARATUS FOR ANTENNA  
PARAMETER NOTIFICATION**

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**G01R 29/10** (2006.01)  
**H04B 1/38** (2015.01)  
**H01Q 1/24** (2006.01)  
**H04B 1/40** (2015.01)

(52) **U.S. Cl.**

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**H04B 1/38** (2013.01); **H04B 1/40** (2013.01)

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**G01R 29/10**  
USPC ..... **342/360**  
See application file for complete search history.

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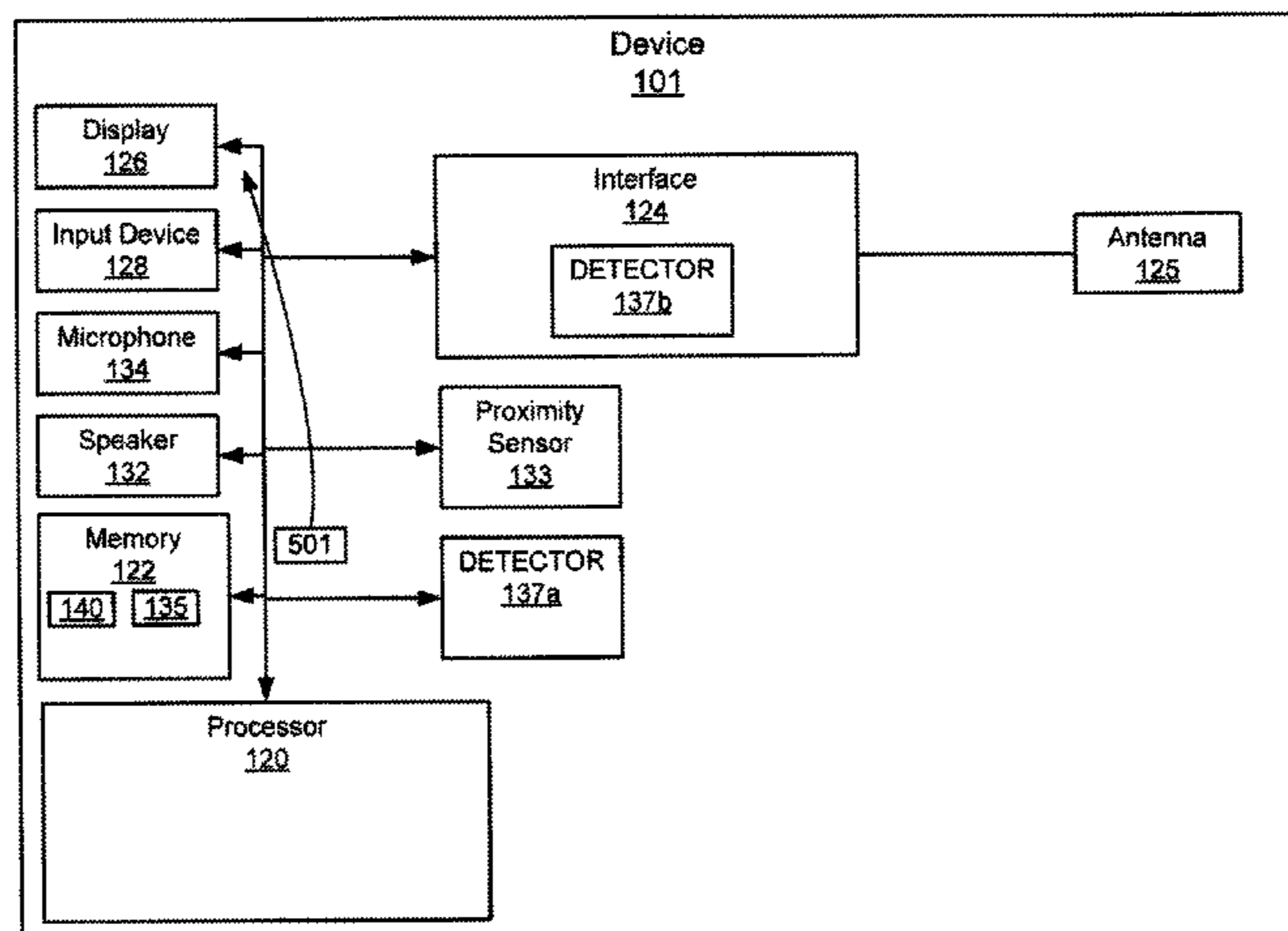
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(57) **ABSTRACT**

A method and apparatus for antenna parameter notification is  
provided. At a device comprising at least one processor, an  
antenna, and a display, a parameter associated with perfor-  
mance of the antenna is determined at the processor. When the  
parameter meets a given criteria then the processor changes a  
brightness of the display.

**13 Claims, 6 Drawing Sheets**



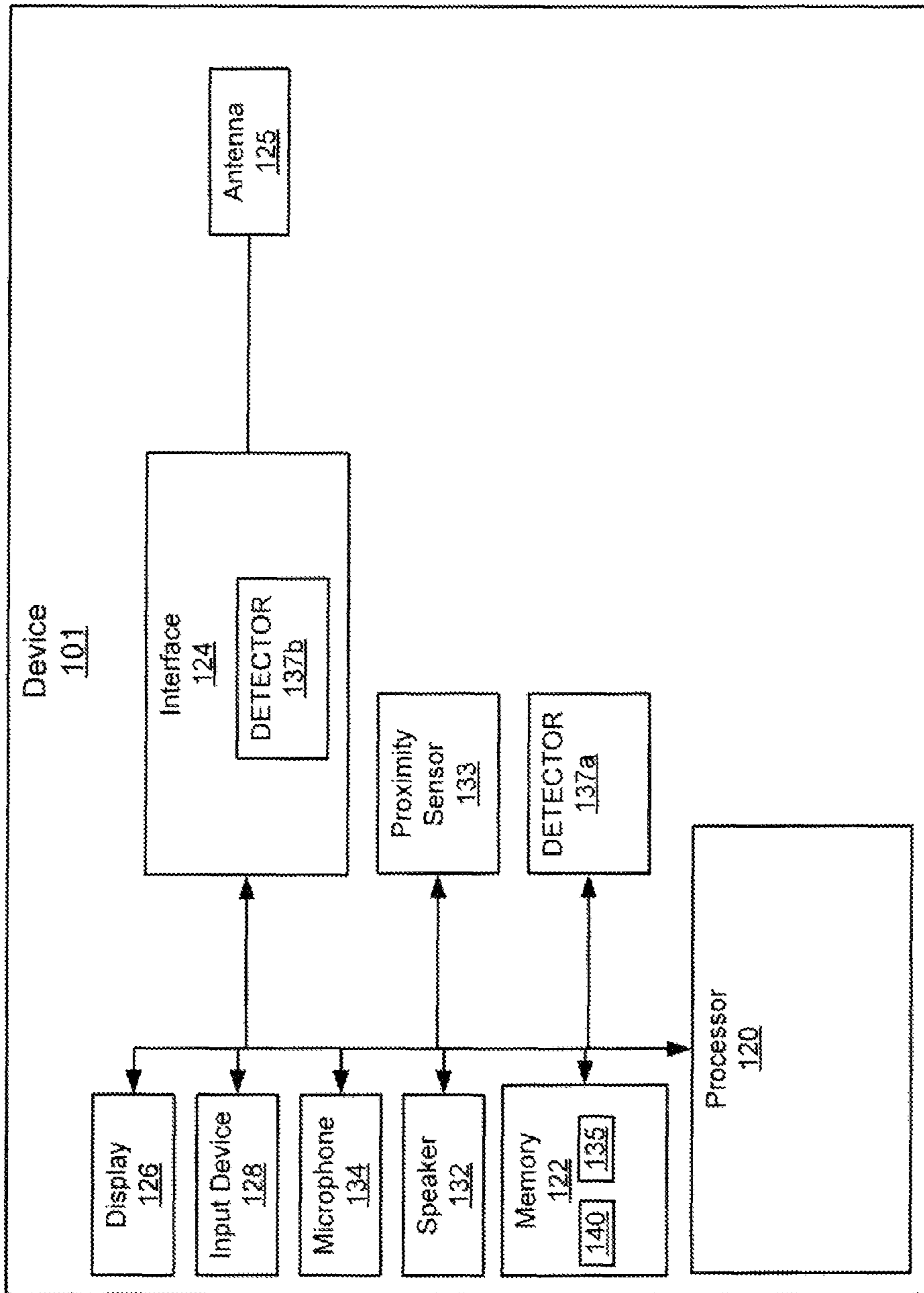


Fig. 1

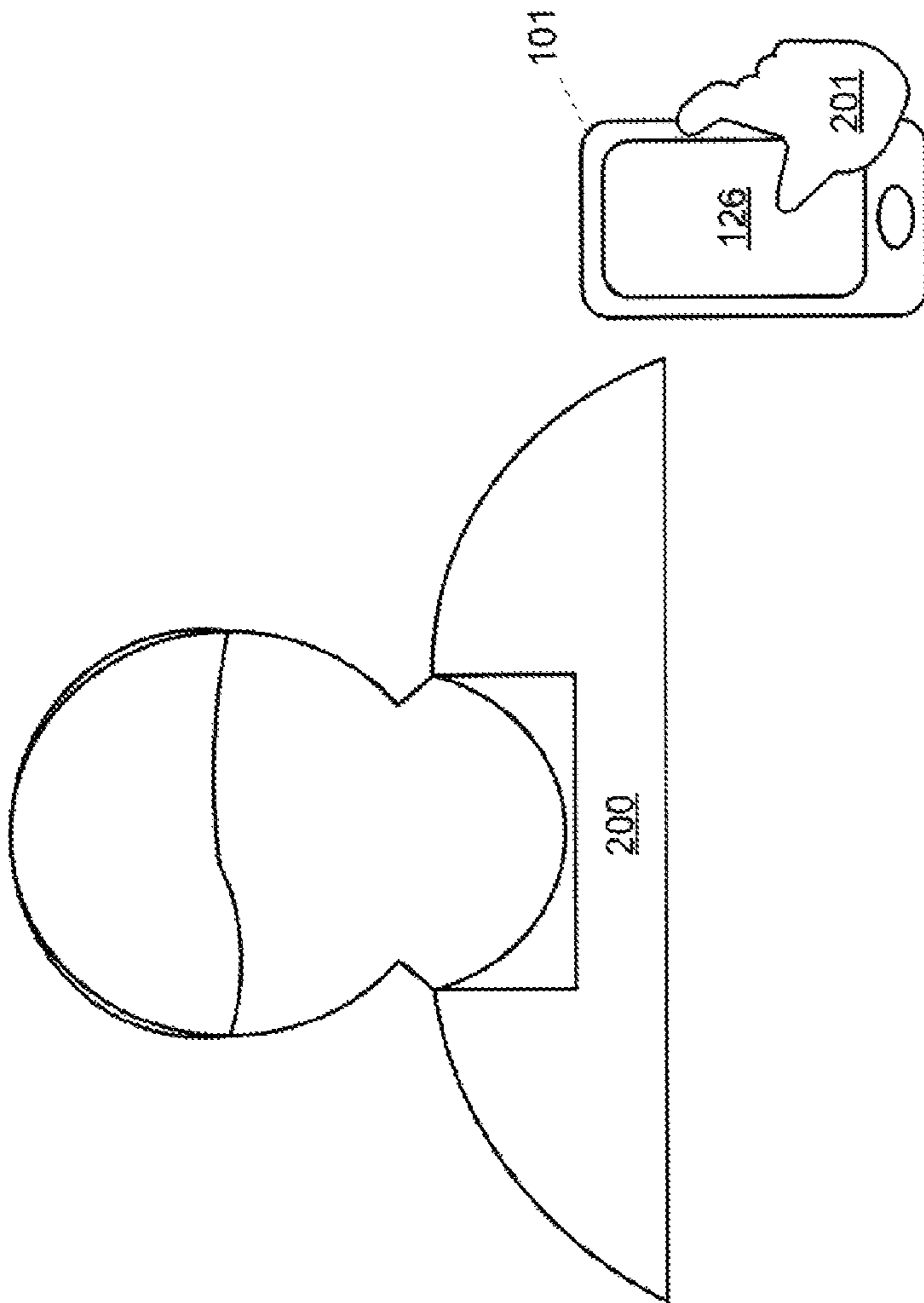


Fig. 2

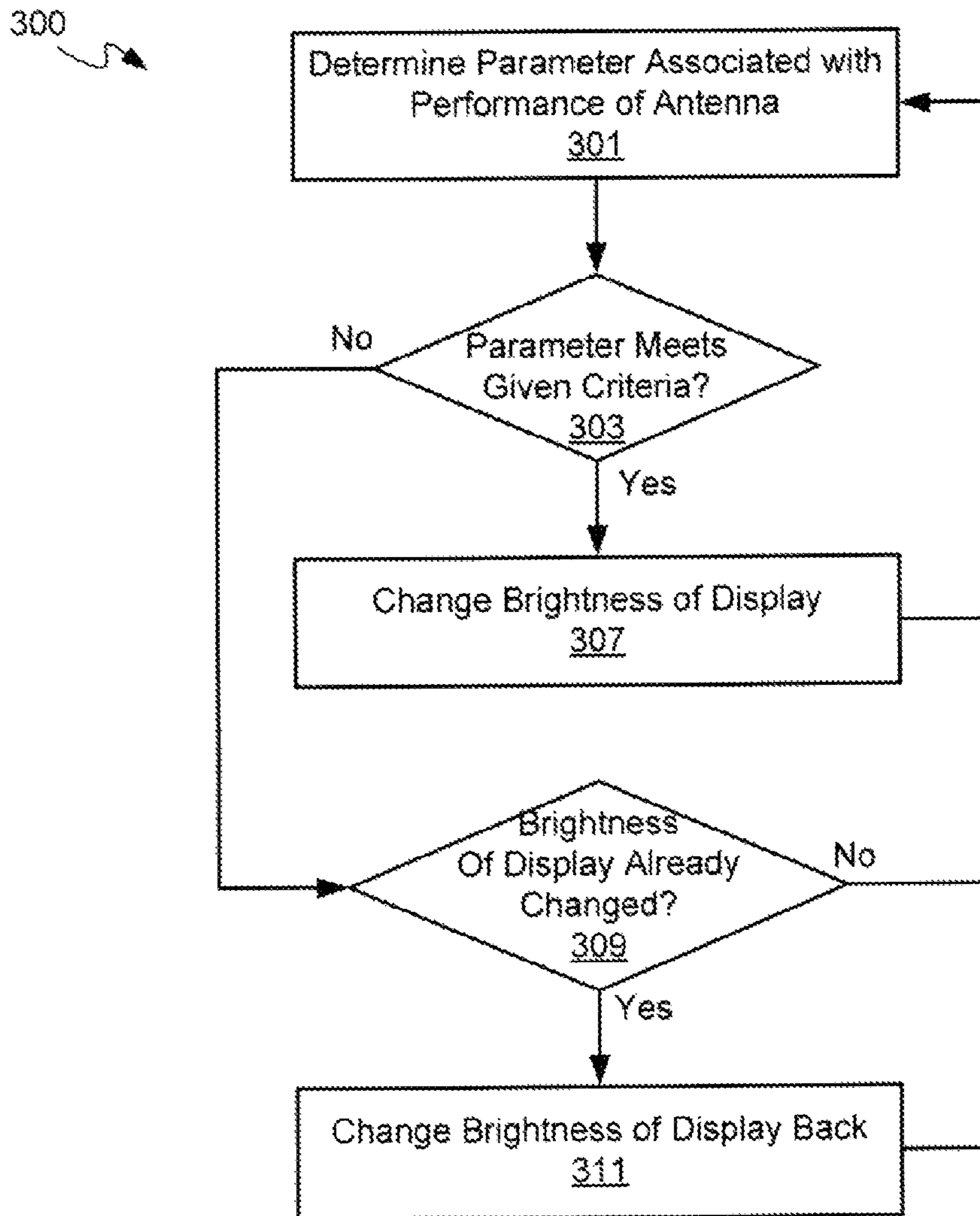


Fig. 3

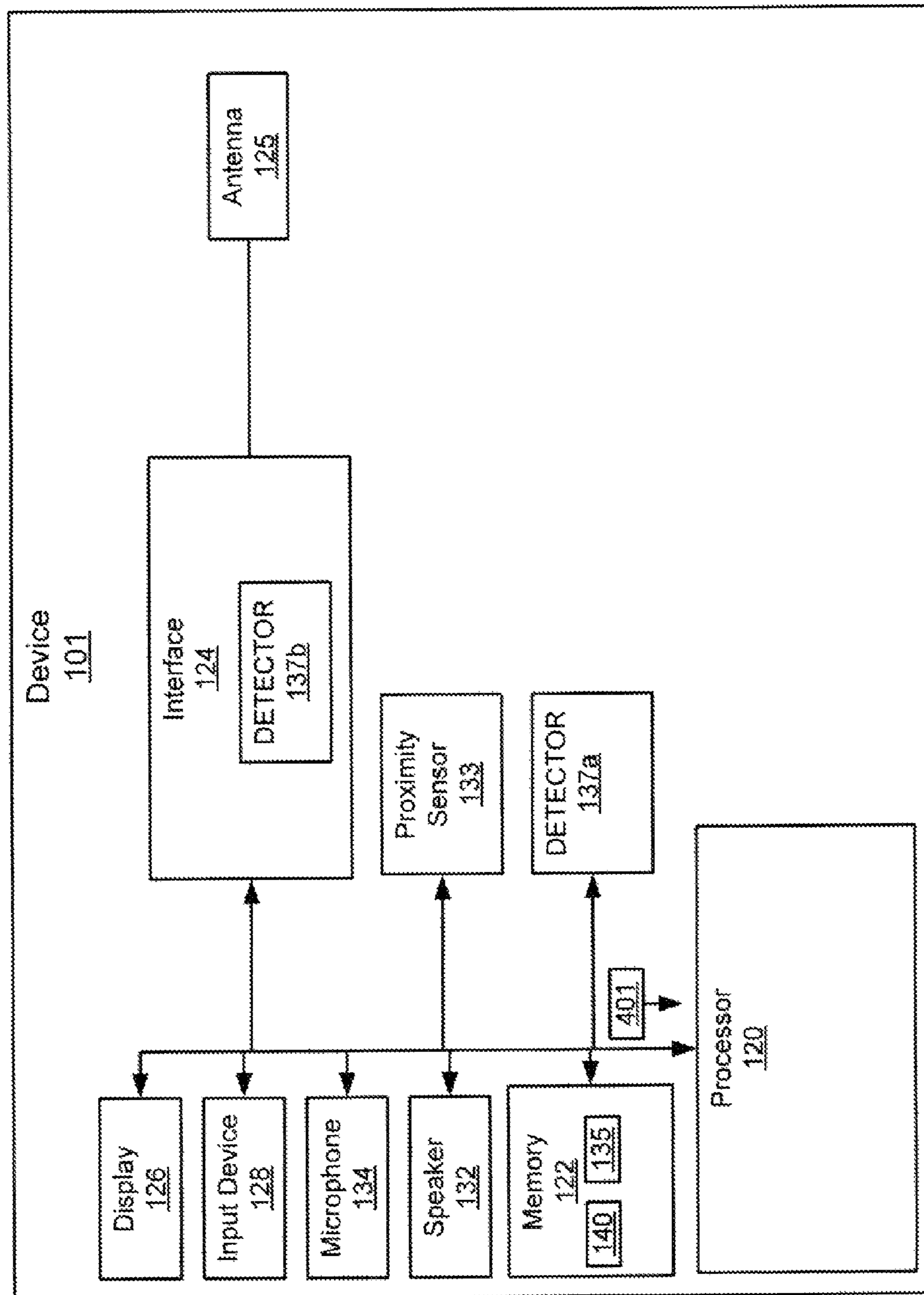


Fig. 4



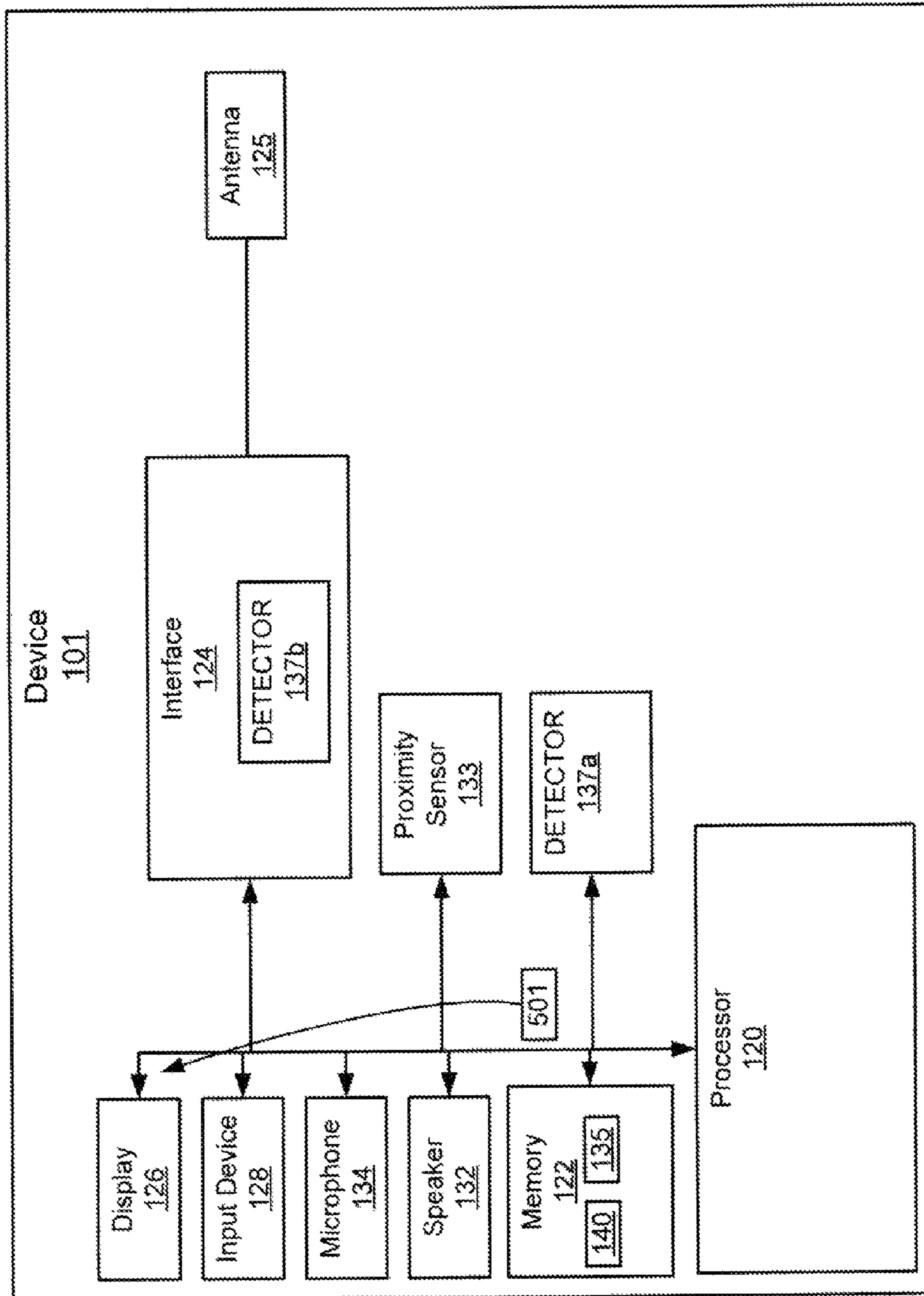


Fig. 5

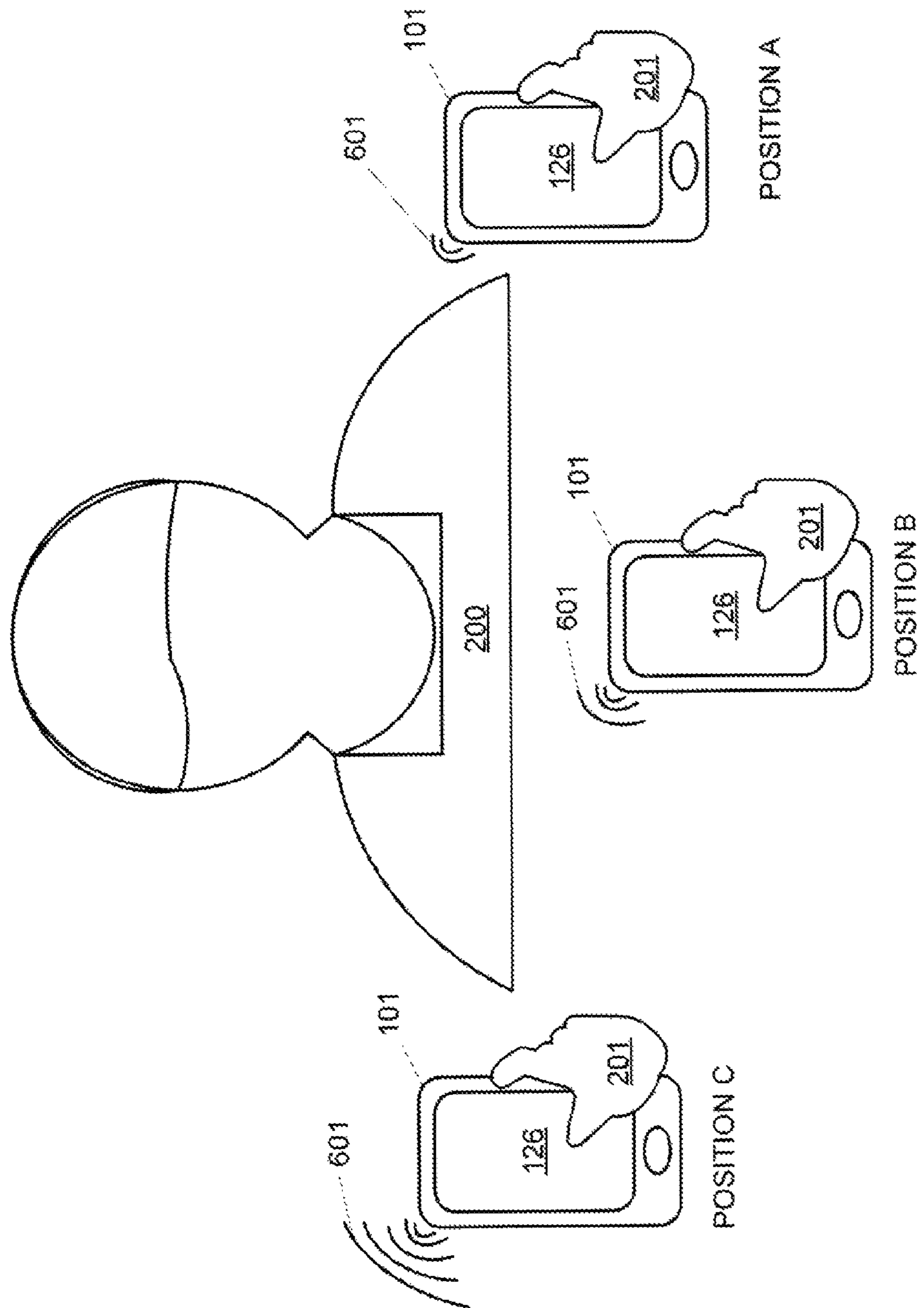


Fig. 6



## METHOD AND APPARATUS FOR ANTENNA PARAMETER NOTIFICATION

### FIELD

The specification relates generally to antennas, and specifically to a method and apparatus for antenna parameter notification.

### BACKGROUND

Mobile devices are generally trending towards being slimmer (and even flexible), with MIMO (multiple-in-multiple-out) antennas. In such mobile devices, tuneable antennas and adaptive impedance matching techniques are important. However, for some cases, such dynamic techniques do not provide optimized radio performance. For example, device orientation, device shape, slider and/or flip position, hand position, interference between multiple radios, SAR (specific absorption rate) requirements and the like, all affect antenna performance due to resulting changes in coupling, out of tuning range, and the like.

### BRIEF DESCRIPTIONS OF THE DRAWINGS

For a better understanding of the various implementations described herein and to show more clearly how they may be carried into effect, reference will now be made, by way of example only, to the accompanying drawings in which:

FIG. 1 depicts a schematic diagram of device for antenna parameter notification, according to non-limiting implementations.

FIG. 2 depicts a perspective view of the device of FIG. 1 in use, according to non-limiting implementations.

FIG. 3 depicts a flowchart of a method for antenna parameter notification, according to non-limiting implementations.

FIG. 4 depicts the device of FIG. 1 showing a determination of a parameter associated with antenna performance, according to non-limiting implementations.

FIG. 5 depicts the device of FIG. 1 showing a processor changing a display brightness in response to the parameter meeting a given criteria and a determination of a proximity, according to non-limiting implementations.

FIG. 6 depicts a perspective view of the device of FIG. 1 with the brightness of a display being increased, according to non-limiting implementations.

### DETAILED DESCRIPTION

A first aspect of the specification provides a device comprising: at least one processor, an antenna, and a display, the at least one processor enabled to: determine a parameter associated with performance of the antenna; and, when the parameter meets a given criteria then change a brightness of the display.

The parameter can comprise one or more of a SAR parameter, an impedance parameter, a voice quality parameter, a VSWR parameter, a FER parameter, an EVM parameter, a BER parameter, a bandwidth parameter, and a QoS parameter, and the given criteria respectively comprises one or more of a threshold SAR level, one or more of a threshold impedance level and a given range of acceptable impedance levels, one or more voice quality threshold levels, one or more VSWR thresholds, one or more FER thresholds, one or more EVM thresholds, one or more BER thresholds, one or more bandwidth thresholds, and one or more QoS thresholds.

The parameter can comprise a reception of the antenna, and the given criteria can comprise the reception being out of a given range thereby indicating poor reception at the antenna.

The parameter can comprise an impedance of the antenna, and the given criteria can comprise the impedance being out of a given range thereby indicating impedance mismatch between the antenna and associated radio equipment.

The parameter can comprise voice quality provided at the speaker, and the given criteria can comprise the voice quality being below a given voice quality threshold level.

The processor can be further enabled to change the brightness of the display as a function of the parameter, such that change in the brightness of the display varies according to the parameter.

The processor can be further enabled to monitor the parameter and change the brightness of the display in a feedback loop with the parameter.

The processor can be further enabled to change the brightness of the display in a pattern.

At least a portion of the device can be flexible and the processor can be further enabled to change the brightness of the display as a shape of the device changes.

Another aspect of the specification provides a method comprising: at a device comprising at least one processor, an antenna, and a display, determining, at the processor, a parameter associated with performance of the antenna; and, when the parameter meets a given criteria then changing a brightness of the display.

The parameter can comprise one or more of a SAR parameter, an impedance parameter, a voice quality parameter, a VSWR parameter, a FER parameter, an EVM parameter, a BER parameter, a bandwidth parameter, and a QoS parameter, and the given criteria respectively can comprise one or more of a threshold SAR level, one or more of a threshold impedance level and a given range of acceptable impedance levels, one or more voice quality threshold levels, one or more VSWR thresholds, one or more FER thresholds, one or more EVM thresholds, one or more BER thresholds, one or more bandwidth thresholds, and one or more QoS thresholds.

The parameter can comprise a reception of the antenna, and the given criteria can comprise the reception being out of a given range thereby indicating poor reception at the antenna.

The parameter can comprise an impedance of the antenna, and the given criteria can comprise the impedance being out of a given range thereby indicating impedance mismatch between the antenna and associated radio equipment.

The parameter can comprise voice quality provided at the speaker, and the given criteria can comprise the voice quality being below a given voice quality threshold level.

The method can further comprise changing the brightness of the display as a function of the parameter, such that change in the brightness of the display varies according to the parameter.

The method can further comprise monitoring the parameter and changing the brightness of the display in a feedback loop with the parameter.

The method can further comprise changing the brightness of the display in a pattern.

At least a portion of the device can be flexible and the method further can comprise changing the brightness of the display as a shape of the device changes.

Yet another aspect of the specification provides a computer program product, comprising a computer usable medium having a computer readable program code adapted to be executed to implement a method comprising: at a device comprising at least one processor, an antenna, and a display, determining, at the processor, a parameter associated with



performance of the antenna; and, when the parameter meets a given criteria then changing a brightness of the display. The computer program product can be non-transitory.

FIG. 1 depicts a schematic diagram of a device 101 for antenna parameter notification, according to non-limiting implementations. Device 101 comprises a processor 120 interconnected with a memory 122, a communications interface 124, an antenna 125, a display 126, an input device 128, a speaker 132, at least one optional proximity sensor 133, and a microphone 134. Communications interface 124 will be interchangeably referred to as interface 124. As will be presently explained, processor 120 is generally enabled for antenna parameter notification; specifically, processor 120 is enabled to: determine a parameter associated with performance of antenna 125; and, when the parameter meets a given criteria 135, stored at memory 122, then change a brightness of display 126.

It is appreciated that brightness can include any suitable indication of brightness, including, but not limited to, luminance, luminous intensity, and the like. It is yet further appreciated that changing a brightness of display 126 can comprise controlling an electrical property of display 126, including but not limited to one or more of a voltage and a current.

Device 101 can be any type of electronic device that can be used in a self-contained manner to communicate with one or more communication networks using antenna 125. Device 101 includes, but is not limited to, any suitable combination of electronic devices, communications devices, computing devices, personal computers, laptop computers, portable electronic devices, mobile computing devices, portable computing devices, tablet computing devices, laptop computing devices, desktop phones, telephones, PDAs (personal digital assistants), cellphones, smartphones, e-readers, internet-enabled appliances and the like. Other suitable devices are within the scope of present implementations.

However, it is appreciated that, regardless of the configuration of device 101, device 101 is generally enabled to control a brightness of display 126, for example as depicted in FIG. 2, which depicts a perspective view of device 101 in use. Specifically, in FIG. 2, a user 200 is holding device 101 in his/her hand 201, for example in a position so that user 200 can see display 126. Display 126 can be controlled when user 200 is holding device 101. In some implementations, device 101 can be in use in FIG. 2 during a telephone call conducted using a speakerphone mode at device 101 such that a telephone call can be conducted while user 200 can view display 126.

Attention is now directed back to FIG. 1: it should be emphasized that the structure of device 101 in FIG. 1 is purely an example, and contemplates a device that can be used for both wireless voice (e.g. telephony) and wireless data communications (e.g. email, web browsing, text, and the like). However, while FIG. 1 contemplates a device that can be used for telephony, in other implementations, device 101 can comprise a device enabled for implementing any other suitable specialized functions, including, but not limited, to one or more of, computing, appliance, and/or entertainment related functions.

Device 101 comprises at least one input device 128 generally enabled to receive input data, and can comprise any suitable combination of input devices, including but not limited to a keyboard, a keypad, a pointing device, a mouse, a track wheel, a trackball, a touchpad, a touch screen and the like. Other suitable input devices are within the scope of present implementations.

Input from input device 128 is received at processor 120 (which can be implemented as a plurality of processors,

including but not limited to one or more central processors (CPUs)). Processor 120 is configured to communicate with a memory 122 comprising a non-volatile storage unit (e.g. Erasable Electronic Programmable Read Only Memory (“EEPROM”), Flash Memory) and a volatile storage unit (e.g. random access memory (“RAM”). Programming instructions that implement the functional teachings of device 101 as described herein are typically maintained, persistently, in memory 122 and used by processor 120 which makes appropriate utilization of volatile storage during the execution of such programming instructions. Those skilled in the art will now recognize that memory 122 is an example of computer readable media that can store programming instructions executable on processor 120. Furthermore, memory 122 is also an example of a memory unit and/or memory module.

In particular, it is appreciated that memory 122 stores an application 140 that, when processed by processor 120, enables processor 120 to: determine a parameter associated with performance of antenna 125; and, when the parameter meets a given criteria 135, stored at memory 122, then change a brightness of display 126.

The brightness of display 126 can be increased or decreased. In some implementations, the brightness of display 126 is changed to a given brightness level stored at memory 122.

Processor 120 can be further configured to communicate with display 126, and microphone 134 and speaker 132. Display 126 comprises any suitable one of, or combination of, CRT (cathode ray tube) and/or flat panel displays (e.g. LCD (liquid crystal display), plasma, OLED (organic light emitting diode), capacitive or resistive touchscreens, and the like). In implementations where display 126 comprises an LCD display, display 126 further comprises a backlight (not depicted), which is controlled by processor 120 to, in turn, control brightness of display 126.

Microphone 134, comprises any suitable microphone for receiving sound data.

Speaker 132 comprises any suitable speaker for providing sound data, audible alerts, audible communications from remote communication devices, and the like, at device 101.

In some implementations, input device 128 and display 126 are external to device 101, with processor 120 in communication with each of input device 128 and display 126 via a suitable connection and/or link.

Processor 120 also connects to interface 124, which can be implemented as one or more radios and/or connectors and/or network adaptors, configured to wirelessly communicate with one or more communication networks (not depicted) via antenna 125. It will be appreciated that interface 124 is configured to correspond with network architecture that is used to implement one or more communication links to the one or more communication networks, including but not limited to any suitable combination of USB (universal serial bus) cables, serial cables, wireless links, cell-phone links, cellular network links (including but not limited to 2G, 2.5G, 3G, 4G+, UMTS (Universal Mobile Telecommunications System), CDMA (Code division multiple access), WCDMA (Wideband CDMA), FDD (frequency division duplexing), TDD (time division duplexing), TDD-LTE (TDD-Long Term Evolution), TD-SCDMA (Time Division Synchronous Code Division Multiple Access) and the like, wireless data, Bluetooth links, NFC (near field communication) links, WiFi links, WiMax links, packet based links, the Internet, analog networks, the PSTN (public switched telephone network), access points, and the like, and/or a combination.

Specifically, interface 124 comprises radio equipment (i.e. a radio transmitter and/or radio receiver) for receiving and



transmitting signals using antenna **125**. It is further appreciated that interface **124** can comprise a variable tuning circuit for tuning antenna **125**, for example by matching impedance of antenna **125** to the radio equipment. The variable tuning circuit can hence comprise any suitable combination of capacitors and impedance coils (also referred to as inductors) for matching impedance of antenna **125** to the radio equipment of interface **124**.

It is appreciated that processor **120** is generally enabled to determine a parameter associated with performance of antenna **125**. The parameter can comprise one of or more of a reception parameter, a SAR parameter, an impedance parameter, a voice quality parameter, a VSWR (voltage standing wave ratio) parameter, a FER (frame error rate) parameter, an EVM (error vector magnitude) parameter, a BER (bit error rate) parameter, a bandwidth parameter, and a QoS (Quality of Service) parameter.

As such, device **101** can further comprise one or more detectors **137a**, **137b** (also referred to hereafter, generically, as a detector **137** and collectively as detectors **137**) for measuring the parameter, including, but not limited to, one or more of a reception detector, a SAR detector, an impedance detector, a voice quality detector, a VSWR detector, an FER detector, an EVM detector, a BER detector, a bandwidth detector, and a QoS detector. It is further appreciated that detectors **137** can be implemented as a combination of hardware and software. For example, when one or more of detectors **137** comprise a BER detector, processor **120** can comprise one or more of detectors **137** implemented as software.

When implemented as hardware, one or more of detectors **137** can be a distinct component of device **101** and/or one or more of detectors **137** can be an element of interface **124**.

For example, in some implementations, detector **137a**, at interface **124**, can comprise a detector for detecting reception of antenna **125**. Hence, in yet further implementations, interface **124** can comprise a processor associated with one or more of radio equipment, a variable tuning circuit and detector **137b**.

In other implementations, detector **137a** can comprise a SAR detector for detecting SAR at device **101**. In other implementations, detector **137b**, at interface **124**, can comprise one or more of a reception detector and a SAR detector, as interface **124** is in communication with antenna **125** and can determine a level of radiation being received and/or transmitted by antenna **125**.

In other implementations, detector **137a** can comprise a detector for detecting voice quality at speaker **132**; for example when antenna performance is low (i.e. when impedance matching is poor and/or radio signal quality is low) voice quality in a telephone call can be affected; for example, the volume can be reduced, noise can increase, and the like. Detector **137a**, implemented as software, hardware and/or a combination thereof, can be enabled to determine voice quality. In some of these implementations, detector **137a** comprises a digital signal processor (DSP) for determining voice quality.

It is yet further appreciated that interface **124** can comprise detector **137b** which in turn comprises a measurement circuit for measuring reception and/or SAR at antenna **125**.

In other implementations, interface **124** can comprise detector **137b** which in turn comprises a measurement circuit for measuring impedance of antenna **125**, including but not limited to impedance mismatches between antenna **125** and radio equipment at interface **124**. Detector **137b**, when present, can comprise any suitable circuit for measuring reception and/or impedance of antenna **125**, and can hence comprise any suitable combination of signal transmitter, sig-

nal receiver, capacitors and impedance coils for measuring reception and/or impedance of antenna **125**. It is yet further appreciated that detector **137b** can alternatively be enabled to determine radiation levels associated with antenna **125**, and hence SAR can be determined.

In specific non-limiting implementations, device **101** can comprise a phone device, and antenna **125** comprises a main antenna, for example for communicating with a cell phone network.

Optional proximity sensor **133**, when present, can comprise any suitable proximity sensor, including, but not limited to, IR (infrared) diode/detectors, capacitive sensors, capacitive displacement sensors, Doppler effect sensors, eddy-current sensor, inductive sensors, laser sensors, optical sensors, acoustic sensors, magnetic sensors, passive optical sensors (such as charge-coupled devices), passive thermal infrared sensors, photocell sensors (reflective), magnetometers, gyroscopes, accelerometers, altimeters and the like.

Further, proximity sensor **133**, when present, can be located at any position on device **101** for detecting one or more of a head of a user and a hand of a user. For example, proximity sensor **133** can be adjacent speaker **132** such that proximity sensor **133** detects proximity when a head of a user is adjacent speaker **132**, as in FIG. 2. Alternatively, proximity sensor **133** can be positioned at device **101** to detect a hand of a user when user is holding device **101**. In yet further implementations, proximity sensor **133** can comprise one or more proximity sensors for determining proximity when device **101** is being held by a hand of a user. In other words, in some implementations, regardless of the location and/or number of proximity sensor **133**, proximity sensor **133** is enabled to sense one or more of a head-hand mode of device **101** and a hand-held mode of device **101**.

It is further appreciated that such a head-hand mode and/or hand-held mode can be indicated by virtue of determining proximity at proximity detector **133**, and that processor **120** need not make a specific determination of a head-hand mode and/or a hand-held mode.

It is yet further appreciated that device **101** comprises a power source, not depicted, for example a battery or the like. In some implementations the power source can comprise a connection to a mains power supply and a power adaptor (e.g. and AC-to-DC (alternating current to direct current) adaptor).

In any event, it should be understood that a wide variety of configurations for device **101** are contemplated.

Hence attention is now directed to FIG. 3 which depicts a flowchart of a method **300** for antenna parameter notification, according to non-limiting implementations. In order to assist in the explanation of method **300**, it will be assumed that method **300** is performed using device **101** to use display **126** for antenna parameter notification. Furthermore, the following discussion of method **300** will lead to a further understanding of device **101** and its various components. However, it is to be understood that device **101** and/or method **300** can be varied, and need not work exactly as discussed herein in conjunction with each other, and that such variations are within the scope of present implementations.

It is appreciated that, in some implementations, method **300** is implemented in device **101** by processor **120** processing application **140**. Indeed, method **300** is one way in which device **101** can be configured. It is to be emphasized, however, that method **300** need not be performed in the exact sequence as shown, unless otherwise indicated; and likewise various blocks may be performed in parallel rather than in sequence; hence the elements of method **300** are referred to herein as “blocks” rather than “steps”. It is also to be understood, however, that method **300** can be implemented on variations



of device 101 as well. For example, in implementations where interface 124 comprises a processor and method 300 can be implemented at interface 124.

Further, the following discussion of method 300 will be done with reference to FIGS. 4 and 5, each of which are similar to FIG. 1, with like elements having like numbers.

At block 301, processor 120 determines a parameter associated with performance of antenna 125. For example, processor 120 can communicate with one or more of detectors 137 and interface 124 to receive data 401 indicative of performance of antenna 125. The parameter can comprise one of or more of a reception parameter, a SAR parameter, an impedance parameter, a voice quality parameter, a VSWR parameter, a FER parameter, an EVM parameter, a BER parameter, a bandwidth parameter, and a QoS parameter.

For example, in some implementations, the determined parameter can comprise a reception of antenna 125, for example as antenna 125 interacts with a communication network, and hence data 401 is indicative of a reception level. In other implementations, the determined parameter can comprise a SAR level, and hence data 401 is indicative of SAR level. In other implementations, the parameter comprises an impedance of antenna 125, and hence data 401 is indicative of impedance of antenna 125, which in turn can be indicative of an impedance mismatch between antenna 125 and radio equipment at interface 124. In yet further implementations, the parameter comprises an indication of voice quality provided at speaker 132, and hence data 401 is indicative of voice quality at speaker 132. However, it is further appreciated that, in some implementations, the parameter can be determined by processor 120 without receipt of data 401. In other words, in implementations where processor 120 comprises detector 137a, processor 120 can determine the parameter associated with performance of antenna 125 without receipt of data 401.

It is further appreciated that in some implementations, at block 301, more than one parameter can be determined, for example more than one of the parameters described above.

At block 303, processor 120 compares the parameter to given criteria 135. When more than one parameter is determined, each parameter can be compared to respective given criteria 135. Either way, it is appreciated that given criteria 135 is commensurate with the parameter. Hence, when parameter comprises one or more of a reception parameter, a SAR parameter, an impedance parameter, a voice quality parameter, a VSWR parameter, a FER parameter, an EVM parameter, a BER parameter, a bandwidth parameter, and a QoS parameter, given criteria 135 respectively comprises one or more of a threshold reception level, threshold SAR level, one or more threshold impedance levels and for a given range of acceptable impedance levels, one or more voice quality threshold levels, one or more VSWR thresholds, one or more FER thresholds, one or more EVM thresholds, one or more BER thresholds, one or more bandwidth thresholds, and one or more QoS thresholds.

For example, when the parameter comprises a reception of antenna 125, given criteria 135 comprises the reception being out of a given range thereby indicating poor reception at antenna 125. Similarly, when the parameter comprises a SAR level, given criteria 135 can comprise the SAR level exceeding a threshold SAR level, including but not limited to a predetermined threshold SAR level that is considered inappropriate exposure for human beings. When the parameter comprises an impedance of antenna 125, or the like, given criteria 135 can comprise the impedance being out of a given range of impedance, thereby indicating impedance mismatch between antenna 125 and associated radio equipment at interface 124. When the parameter comprises voice quality pro-

vided at speaker 132, given criteria 135 can comprise the voice quality being below a given voice quality threshold level.

In any event, at block 303, when the parameter does not meet given criteria 135 (i.e. a “No” decision at block 303), blocks 301 and 303 are repeated, presuming that brightness of display 126 has not already been changed (i.e. block 307, described below, has not previously occurred) such that processor 120 is generally enabled to monitor one or more parameters associated with performance of antenna 125. In implementations where more than one parameter is compared to respective criteria 135, memory 122 can store rules for determining priority of the parameters such that when some of parameters do not meet respective given criteria 135, while other parameters do meet respective given criteria 135, a “No” decision is reached at block 303. For example, a SAR level parameter exceeding a threshold SAR level can be given priority over reception of antenna 125 being acceptable.

However, at block 303, when the parameter does meet given criteria 135 (i.e. a “Yes” decision at block 303), at block 307, processor 120 changes brightness at display 126. For example, attention is directed to FIG. 5 where processor 120 controls display 126 132 to change the brightness via a command and/or signal 501.

Such a change in brightness of display 126 is indicative that a parameter associated with performance of antenna 125 has met given criteria 135, and further indicative that the performance of antenna 125 is poor. As a result, the change in brightness of display 126 can serve as a prompt to a user to adjust device 101 to improve performance of antenna 125, for example by adjusting a position of device 101.

Returning to FIG. 3, the brightness of display 126 can be increased or decreased at block 307. In some implementations, the brightness of display 126 is changed to a given brightness level that can be stored at memory 122. It is appreciated that the change in brightness is generally enabled to be noticeable to a human being, as can be determined by a person of skill in the art.

Further at block 307, when processor 120 changes brightness of display 126 (for example to the given brightness), the brightness change can be sudden, for example as a step-function, or the brightness change can be gradual, for example a linear or exponential change over a given time period, such as about 5 seconds or the like.

In yet further implementations, at block 307, processor 120 changes brightness of display 126 as a function of one or more of the parameters, for example according to a function  $B=F(P)$ , where B is the brightness of display 126 expressed in any suitable units, including but not limited to luminance units, F is a suitable function and P is one or more of the parameters. Hence, brightness of display 126 varies according to the one or more parameters, e.g. the parameter, P. In some implementations, the function F can comprise a linear function, while, in other implementations, the function F can comprise an exponential function.

In yet further implementations, the function F can be non-linear, for example a function of two or more of the parameters, such as  $B=F(P_1, P_2, P_3 \dots P_n)$ , where each of  $P_1, P_2, P_3 \dots P_n$  is a different one of the parameters: further while four parameters are shown function F can be dependent on any number of the parameters.

It is further appreciated that, in some implementations, brightness B of function  $B=F(P)$  can be expressed in terms of an electrical parameter of display 126. For example, brightness can be related to one or more a current and a voltage



supplied to display 126, and hence brightness B can be correspondingly expressed as a current and a voltage supplied to display 126.

In any event, once brightness of display 126 is changed at block 307, blocks 301 to 303 occur again. When block 307 is reached again (i.e. the parameter continues to meet given criteria 135), the brightness of display 126 can again be changed. Alternatively, when the brightness of display 126 has already been changed, no further changes occur.

However, when a "No" decision is reached at block 303, at block 309 processor 120 determines whether block 307 has been previously implemented, i.e. to determine whether brightness of display 126 has already been changed. If so (i.e. a "Yes" decision at block 309, and processor 120 has already changed the brightness of display 126 at block 307), at block 311, the brightness of display 126 is changed back to a brightness level similar to the brightness of display 126 before block 307 occurred. Blocks 301 to 303 then reoccur until a "Yes" decision again occurs at block 303. It is further appreciated that the brightness of display 126 can be changed at block 311 according to the function  $B=F(P)$  described above.

It is further appreciated that method 300 can be implemented as a feedback loop. In other words, processor 120 can be enabled to monitor the parameter and change (i.e. increase and/or decrease) the brightness of display 126 in a feedback loop with the parameter, such that as the parameter changes, the brightness of display 126 changes, for example according to the function  $B=F(P)$  described above. Hence, when a user sees a change in the brightness of display 126, the user can react by moving device 101 until the user sees the brightness of display 126 change again. The user can hence position device 101 until the brightness of display 126 is stable, and hence the parameter is also stable.

This situation is depicted in FIG. 6, substantially similar to FIG. 2, with like elements having like numbers, where user 200 moves device 101 from Position A to Position B to Position C. At Position A, brightness 601 of display 126 is dimmed, for example due to poor reception at antenna 125 or the like, as described above. At Position B, brightness 601 increases as the reception at antenna 125 is better than at Position A. At Position C, brightness 601 increases again as the reception at antenna 125 is better than at Position B. The increase in brightness 601 is depicted in FIG. 6 by an increase in the number of lines representing brightness 601, but it is appreciated that user 200 will view a luminance of display 126 increasing in intensity.

In yet further implementations, brightness of display 126 can change as a pattern, including but not limited to a periodic pattern. For example, brightness of display 126 can go gradually low, to a bottom limit, then increase to a top limit for a given number of times, until improved antenna parameters and/or improved RF performance occurs.

In some implementations, at least a portion of device 101 is flexible, and the parameter can be affected by the shape of device 101. In these implementations, the processor 120 can be enabled to change the brightness of display 126 as a shape of device 101 changes, which in turn causes the monitored parameter associated with performance of antenna 125 to change.

In this manner, the brightness of display 126 can be controlled by processor 120 to reflect a poor performance of antenna 125, which in turn can cause a user to take action to improve the performance of antenna 125 by moving device 101 as depicted in FIG. 6.

Persons skilled in the art will appreciate that there are yet more alternative implementations and modifications possible. For example, in implementations where device 101

comprises proximity detector 133, method 300 can include a block for determining proximity of one or more of a hand and a head, such that processor 120 can determine whether device 101 is in hand-held mode or a hand-head mode. In some of these implementations, method 300 occurs only when device 101 is in a hand-held mode. For example, method 300 can occur only when proximity detector 133 detects proximity at a rear and/or side of device 101. In others of these implementations, method 300 does not occur when device 101 is in a hand-head mode as presumably display 126 is not visible to a viewer in such a mode. For example, method 300, prior to block 301, processor 120 determines that proximity detector 133 has determined proximity one or more of adjacent display 126 and adjacent speaker 132, indicating that display 126 is not viewable by a user, and method 300 does not occur.

Hence, in general, a display of a device can be used as an indicator to find the best reception for an antenna, which generally improves the performance of the device. Further, by using existing components of the device, no component cost is added to the device.

Those skilled in the art will appreciate that in some implementations, the functionality of device 101 can be implemented using pre-programmed hardware or firmware elements (e.g., application specific integrated circuits (ASICs), electrically erasable programmable read-only memories (EEPROMs), etc.), or other related components. In other implementations, the functionality of device 101 can be achieved using a computing apparatus that has access to a code memory (not shown) which stores computer-readable program code for operation of the computing apparatus. The computer-readable program code could be stored on a computer readable storage medium which is fixed, tangible and readable directly by these components, (e.g., removable diskette, CD-ROM, ROM, fixed disk, USB drive). Furthermore, it is appreciated that the computer-readable program can be stored as a computer program product comprising a computer usable medium. Further, a persistent storage device can comprise the computer readable program code. It is yet further appreciated that the computer-readable program code and/or computer usable medium can comprise a non-transitory computer-readable program code and/or non-transitory computer usable medium. Alternatively, the computer-readable program code could be stored remotely but transmittable to these components via a modem or other interface device connected to a network (including, without limitation, the Internet) over a transmission medium. The transmission medium can be either a non-mobile medium (e.g., optical and/or digital and/or analog communications lines) or a mobile medium (e.g., microwave, infrared, free-space optical or other transmission schemes) or a combination thereof.

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Persons skilled in the art will appreciate that there are yet more alternative implementations and modifications possible, and that the above examples are only illustrations of one or more implementations. The scope, therefore, is only to be limited by the claims appended hereto.

What is claimed is:

1. A device comprising:
  - at least one processor interconnected with an antenna, and
  - a display, the display comprising a backlight, the back-



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light controlled by the at least one processor to control a brightness of the display, the at least one processor configured to:

determine two or more parameters associated with performance of the antenna;

when the two or more parameters meets a given criteria then smoothly change a brightness of the display by controlling the backlight as a function of the two or more parameters, the function comprising  $B=F(P1, P2, P3 \dots Pn)$ , where B is the brightness of the display, where each of P1, P2, P3 . . . Pn is a different one of the two or more parameters, and F is one or more of a smoothly changing function, a linear function, and an exponential function, the brightness of the display smoothly increasing when one or more of the two or more parameter increases and the brightness of the display smoothly decreasing when one or more of the two or more parameter decreases, such that change in the brightness of the display varies smoothly according to the two or more parameters; and

monitor the two or more parameters and smoothly change the brightness of the display in a feedback loop with the two or more parameters.

2. The device of claim 1, wherein the two or more parameters comprise one or more of a SAR parameter, an impedance parameter, a voice quality parameter, a VSWR parameter, a FER parameter, an EVM parameter, a BER parameter, a bandwidth parameter, and a QoS parameter, and the given criteria respectively comprises one or more of a threshold SAR level, one or more of a threshold impedance level and a given range of acceptable impedance levels, one or more voice quality threshold levels, one or more VSWR thresholds, one or more FER thresholds, one or more EVM thresholds, one or more BER thresholds, one or more bandwidth thresholds, and one or more QoS thresholds.

3. The device of claim 1, wherein the two or more parameters comprise a reception of the antenna, and the given criteria comprises the reception being out of a given range thereby indicating poor reception at the antenna.

4. The device of claim 1, wherein the two or more parameters comprise an impedance of the antenna, and the given criteria comprises the impedance being out of a given range thereby indicating impedance mismatch between the antenna and associated radio equipment.

5. The device of claim 1, wherein the two or more parameters comprises voice quality provided at a speaker, and the given criteria comprises the voice quality being below a given voice quality threshold level.

6. The device of claim 1, wherein the processor is further configured to change the brightness of the display in a pattern.

7. A method comprising:

at a device comprising at least one processor interconnected with an antenna, and a display, the display comprising a backlight, the backlight controlled by the at least one processor to control a brightness of the display, determining, at the processor, two or more parameters associated with performance of the antenna;

when the two or more parameters meets a given criteria then smoothly changing a brightness of the display by the at least one processor controlling the backlight as a function of the two or more parameters, the function comprising  $B=F(P1, P2, P3 \dots Pn)$ , where B is the brightness of the display, where each of P1, P2, P3 . . . Pn is a different one of the two or more parameters, and F is one or more of a smoothly changing function, a linear

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function, and an exponential function, the brightness of the display smoothly increasing when one or more of the two or more parameter increases and the brightness of the display smoothly decreasing when one or more of the two or more parameter decreases, such that change in the brightness of the display varies smoothly according to the two or more parameters; and

monitoring the two or more parameters and smoothly changing the brightness of the display in a feedback loop with the two or more parameters.

8. The method of claim 7, wherein the two or more parameters comprise one or more of a SAR parameter, an impedance parameter, a voice quality parameter, a VSWR parameter, a FER parameter, an EVM parameter, a BER parameter, a bandwidth parameter, and a QoS parameter, and the given criteria respectively comprises one or more of a threshold SAR level, one or more of a threshold impedance level and a given range of acceptable impedance levels, one or more voice quality threshold levels, one or more VSWR thresholds, one or more FER thresholds, one or more EVM thresholds, one or more BER thresholds, one or more bandwidth thresholds, and one or more QoS thresholds.

9. The method of claim 7, wherein the two or more parameters comprise a reception of the antenna, and the given criteria comprises the reception being out of a given range thereby indicating poor reception at the antenna.

10. The method of claim 7, wherein the two or more parameters comprise an impedance of the antenna, and the given criteria comprises the impedance being out of a given range thereby indicating impedance mismatch between the antenna and associated radio equipment.

11. The method of claim 7, wherein the two or more parameters comprise voice quality provided at a speaker, and the given criteria comprises the voice quality being below a given voice quality threshold level.

12. The method of claim 7, further comprising changing the brightness of the display in a pattern.

13. A non-transitory computer-readable medium storing a computer program, wherein execution of the computer program is for:

at a device comprising at least one processor interconnected with an antenna, and a display, the display comprising a backlight, the backlight controlled by the at least one processor to control a brightness of the display, determining, at the processor, two or more parameters associated with performance of the antenna;

when the two or more parameters meets a given criteria then smoothly changing a brightness of the display by the at least one processor controlling the backlight as a function of the two or more parameters, the function comprising  $B=F(P1, P2, P3 \dots Pn)$ , where B is the brightness of the display, where each of P1, P2, P3 . . . Pn is a different one of the two or more parameters, and F is one or more of a smoothly changing function, a linear function, and an exponential function, the brightness of the display smoothly increasing when one or more of the two or more parameter increases and the brightness of the display smoothly decreasing when one or more of the two or more parameter decreases, such that change in the brightness of the display varies smoothly according to the two or more parameters; and

monitoring the two or more parameters and smoothly changing the brightness of the display in a feedback loop with the two or more parameters.

UNITED STATES PATENT AND TRADEMARK OFFICE  
**CERTIFICATE OF CORRECTION**

PATENT NO. : 9,170,289 B2  
APPLICATION NO. : 13/541704  
DATED : October 27, 2015  
INVENTOR(S) : Mahinthan Velupillai and Nagula Tharma Sangary

Page 1 of 1

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

In the Claims

Column 11 Claim 1, Line 6, the word “meets” should be replaced with “meet”.

Column 11 Claim 1, Line 16, the word “parameter” should be replaced with “parameters”.

Column 11 Claim 1, Line 18, the word “parameter” should be replaced with “parameters”.

Column 11 Claim 4, Line 41, it should read “comprises” not “a comprise”.

Signed and Sealed this  
Thirtieth Day of January, 2018



Joseph Matal

*Performing the Functions and Duties of the  
Under Secretary of Commerce for Intellectual Property and  
Director of the United States Patent and Trademark Office*